CFAES

Department of Entomology

Effect of Insecticides, Fungicides, and Adjuvant Combinations on Honey Bee Brood Development

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INTRODUCTION

- Almost 2 million honey bees are vital pollinators in California's Central Valley almond orchards which produce over 80% of the world's almonds
- These almond flowers are commonly treated with adjuvants to enhance the efficacy of the variety of insecticides and fungicides to minimize crop damage (**Figure 1A-C**)
- Pollinating beekeepers have reported late-stage brood mortality and occasional adult mortality in subsequent weeks following almond blooms
- Recent research has demonstrated that some of these preventative treatments negatively impact adult and larval honey bee health due to exposure (Wade et al. 2019)

RESEARCH QUESTIONS

1. Does Dyne-Amic, a commonly used organosilicone-based methylated seed oil surfactant, increase mortality in developing honey bee larvae?

2. Does the presence of Dyne-Amic intensify the toxicity of of commonly used insecticides, fungicides, and combinations to larval honey bees?

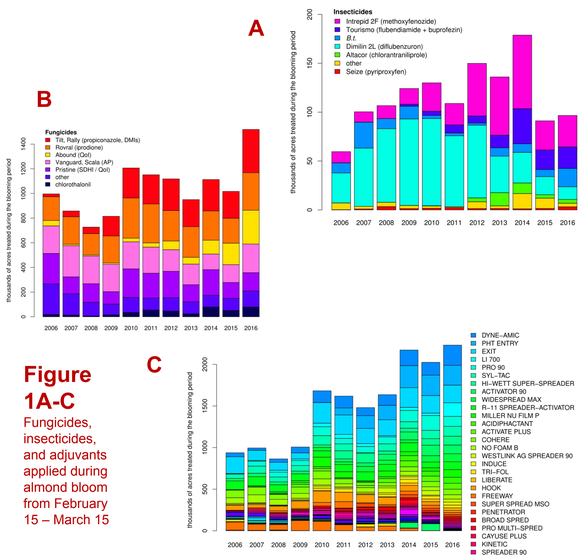


Figure 1A-C Fungicides, insecticides, and adjuvants applied during almond bloom from February 15 – March 15

METHODS

- Larval bioassays were performed using *in vitro* rearing of honey bee workers (Schmehl et al. 2016)
- Young larvae (24 hr old) were grafted from brood frames into 48-well culture plates
- Post 72 hr acclimation, groups of 16 healthy larvae were selected for treatment
- 4 days after grafting, each larva was fed with 30 µL of royal jelly containing various concentrations of Dyne-Amic (**Table 1**)
- 15 trials were performed with 16 bees per treatment group
- Mortality and survival rates were tracked until 20 days after grafting
- An additional 7 trials were performed with 12 bees per treatment group using 0.33% Dyne-amic added to the royal jelly in addition to various combinations of insecticides and fungicides (**Table 2**)

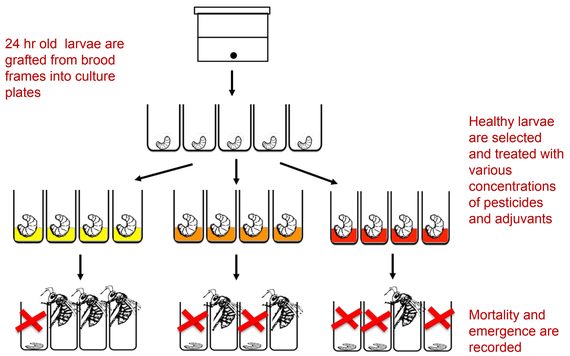


Table 1 Dyne-Amic Concentrations added to royal jelly, sugar, and yeast diet (%)

Dyne-Amic Concentrations	
0.17	0.83
0.25	1.00
0.33	1.17
0.42	1.33
0.50	1.50
0.67	1.75
0.75	2.00

Table 2 Treatment Combinations with 0.33% Dyne-Amic added to royal jelly, sugar, and yeast diet

Insecticide/Fungicide Treatments	Concentrations Tested (% of prepared diet)	Fungicide Insecticide Ratio
Chlorantraniliprole (Altacor)	0.83	
Diflubenzuron (Dimilin)	0.33	
Methoxyfenozide (Intrepid)	1.00	
Iprodione (Rovral)	1.00	
Propiconazole (Tilt)	1.00	
Chlorantraniliprole (Altacor) + Propiconazole (Tilt)	1.00	1 : 2.2
Chlorantraniliprole (Altacor) + Iprodione (Rovral)	1.00	1 : 4.9

Insecticide
Fungicide

RESULTS

- Mortality was observed in various stages of development but most notably in the larval stage (**Figure 2)**
- Larval and pupal mortality were observed for Dyne-Amic alone (**Figure 3**) indicating that the presence of adjuvants may be contributing to brood mortality in honey bee colonies.
- Furthermore, the data demonstrated that the LC50 for Dyne-Amic is 1.2%, 1.9x higher than the recommended field application rate of 3 oz/gallon or 2.34%
- No difference in mortality was observed with treatment combinations with Dyne-Amic

Figure 2 Different stages of larval mortality

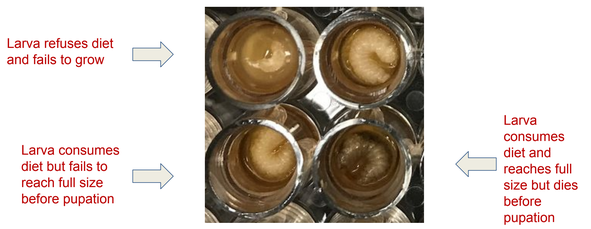
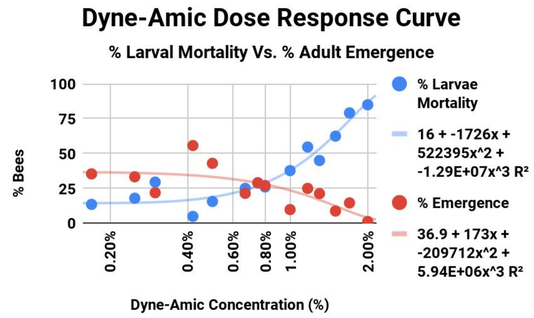


Figure 3 Dyne-Amic dose response curve demonstrating the impact of increasing Dyne-Amic concentration on larval mortality and subsequent adult emergence



CONCLUSIONS

- The results of this study indicate that Dyne-Amic alone is capable of killing larvae and pupae
- The exact mechanism is unknown although failure to successfully pupate or eclose suggests a maturation pathway is inhibited
- Preliminary results did not demonstrate an increase in mortality rate when Dyne-Amic was combined with the fungicides and insecticides
- A number of factors could be contributing to these results including the season and the sublethal concentrations
- Further trials are necessary to truly observe any synergistic effect, if any exist

BIBLIOGRAPHY

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